6.3 LAGOONS

This section discusses the purpose and need ~~of~~ for wastewater storage structures at wastewater land treatment facilities, design requirements, and seepage testing protocol.

6.3.1 LAGOONS: PURPOSE AND NEED

Storage of wastewater is needed for some land ~~application~~ treatment systems. Wastewater generation and treatment plants typically have one to several lagoons serving various purposes. The storage volume can vary from as little as one day's flow to as much as six months. Storage is needed when precipitation produces an excessive hydraulic load on the soil crop system; when cultivating practices prevent application; when winter weather conditions preclude operation; when flow variations in quantity and quality requires equalization; when winter weather forces a reduction in the rate of application; and as a backup for the treatment system under emergency situations. It is possible to reduce or remove storage requirements by providing alternative backup measures to be determined on a case-by-case basis.

The key elements to consider when determining storage requirements are the local climate and the period of operation. Storage is generally needed during the harsh winter months when application rates must be reduced. Evaluation of these elements helps to determine the needed storage volume. Analysis of rainfall data also helps identify the storage needs related to expected periods of excessive precipitation.

In some areas, and depending on wastewater characteristics, the winter weather may be mild enough to allow application during much of the winter. In these cases, consideration must be given to the trade-off of the cost of storage versus the cost of additional area for land application. See Section 4.1 for additional information on non-growing season application and storage practices. See also Section 6.8.1 for information on weed control around lagoons.

It is important for lagoons to be sufficiently sealed so that they do not become major contributors to the contamination of ground water. For this reason, members of the regulated community are required to demonstrate the integrity of their water treatment and storage structures. The following LINK provides guidance for determining seepage rates for lagoons. Alternative methods may be submitted for review and approval DEQ.

6.3.2 LAGOONS: DESIGN CRITERIA

Design criteria for municipal and industrial lagoons is based on Ten State Standards otherwise known as the "Recommended Standards for ~~Sewage Works~~ Wastewater Facilities - 2004" by the Great Lakes-Upper Mississippi River Board of State Sanitary Engineers pursuant to the Idaho Water Quality Standards (IDAPA 58.01.02.402). These design criteria for lagoons require~~s~~ lagoons be designed with a seal that has a seepage rate less than 500 gallons/acre-day (0.018 inches/day).

Performance criteria based on DEQ policy recommends lagoons be allowed to seep at a rate up to 3400 gallons/acre-day (0.125 inches/day), or approximately seven times the design criteria. This rate is based on a perceived allowable error in physically measuring the seepage rate.

DEQ recommends that current seepage data be submitted as part of the permit renewal application package each five years. Results of the seepage data will determine any permit conditions needed to update or modify existing lagoons.

If a properly tested lagoon leaks more than this 0.125 inches per day, the options for mitigation include 1) retesting the seepage rate immediately; 2) properly installing and monitoring appropriate upgradient and downgradient ground water monitoring wells; or 3) repair or replace the liner and retest.

LINK

The following wording is roughly from the seepage testing guidance DEQ has developed for all wastewater lagoons. It is printed here for clarity during this review. However, this portion of the guidance is presently being re-evaluated by DEQ. As the seepage testing guidance is updated, this section 6.3 Lagoons will simply link to the seepage testing guidance elsewhere on the DEQ website.

6.3.3 Procedure for Evaluating Wastewater Treatment Lagoon Seepage Rates

The purpose of this section is to establish a uniform standard procedure by which ~~new and existing~~ wastewater treatment lagoons can be evaluated to determine status of compliance with State seepage rate ~~requirements~~ recommendations. ~~The procedure described below has been revised from a previous procedure. The revisions include changing Division to Department, an expanded pan coefficient table, a recommended use of a temperature recorder, such as a "Hobotemp" weatherproof data logger, and a new definition of "mean air temperature".~~

6.3.3.1 Discussion

Wastewater treatment lagoons constructed in the State of Idaho ~~are required to~~ should meet ~~a site-specific~~ the seepage rate as ~~prescribed~~ recommended by the Department of Environmental Quality (DEQ). In the past, measurements to determine compliance with the required seepage rate have been performed utilizing a wide variety of instruments and procedures. Adoption of a standard testing procedure will ensure consistent seepage measurement techniques.

6.3.3.2 Guidance

1. The staff of the Department of Environmental Quality (DEQ) will provide seepage rate allowances to the entity proposing to construct wastewater treatment lagoons. The maximum allowance is 1/8" per day, which equals ~~3,395~~ 3400 gallons/day/acre.

2. Wastewater treatment lagoon plans and specifications submitted to DEQ for review and approval should contain the following standard procedure.

3. Seepage test data shall be submitted for review and approval.

The following guidance material contains two main sections. The first section is a description of DEQ's standard seepage testing procedure. The last section is a suggested specification insert that may be used as guidance when developing a seepage testing procedure for a lagoon liner specification.

6.3.3.3 SEEPAGE TESTING PROCEDURES

Lagoons to be tested should be filled and maintained at design operational depth for at least two weeks prior to the beginning of the test period to allow for initial saturation (saturation period not required for synthetic lined lagoons). Measurements are to be taken at least every three days over a period of fifteen (15) days (0, 3, 6, 9, 12, 15) or longer until a consistent pattern is evident. One individual ~~is to~~ should be responsible for all measurements and the measurements should be taken at the same hour of each test day.

Equipment[1]

1. Precipitation gauge
2. Temperature recorder, such as a Hobotemp weatherproof data logger
3. Class A evaporation pan and pan stilling well
4. Hook gauge with Vernier scale accurate to 0.001 ft.
5. Appropriate length of six (6) inch PVC pipe (Class 150 for stability) with suitable anchor support base for use as lagoon stilling well
6. Platform with support or boat for access to lagoon stilling well
7. Any necessary flow monitoring equipment

6.3.3.4 EVAPORATION/PRECIPITATION

A precipitation gauge ~~is to~~ should be set up, monitored and recorded daily. The evaporation pan should be located on a level area as close to the lagoon as possible. If necessary, shims should be used to level the pan. The obvious objective is to duplicate lagoon exposure as nearly as possible (sun, wind, rain, etc.). The pan stilling well should be anchored in the pan and not moved once the test period begins. Initial water level in the pan should be about two (2) inches below the lip. Air temperature is monitored to

[1] Items 2, 3, and 4 are available through Forestry Suppliers Inc., P.O. Box 8397, Jackson, MS 39284-8397, (800) 647-5368 Internet www.forestry-suppliers.com; Fax (800) 543-4203

obtain the mean air temperature during the test period that in turn establishes the appropriate pan coefficient. Mean air temperature shall be defined as the mean of a minimum of 24 hourly temperature recordings in a twenty-four hour period. The measured pan evaporation is multiplied by the pan coefficient (Table 5) to obtain the lagoon evaporation.

6.3.3.5 LAGOON SEAL

The lagoon stilling well should be installed as near to the center of the cell as possible. Access to ~~the~~ a central stilling well is by boat or by installing a temporary platform. Alternative lagoon stilling well locations will be reviewed/approved by DEQ on a site-specific basis. The stilling well must be installed at 90 degrees to the water surface for accurate measurements. (DO NOT impinge upon the stilling well). Mark a spot on top of the stilling well to be used as a position indicator for the hook gage. All measurements must be taken with the hook gauge in the same position.

Each time a water surface is measured, hook gauge readings shall be repeated a minimum of seven (7) times and numerically averaged.

If possible, influent/effluent flows should be blocked to avoid unnecessary complications due to flow measurement errors. DEQ has determined that failure to do so, even using very accurate flow measuring devices (plus or minus 5 % of flow), introduces up to 35 % error just based on the flow measuring. If blocking the flow is not possible, the seepage rate testing will have very little meaning. The permittee should then consider other options such as ground water monitoring.

6.3.3.6 GENERAL NOTES

1. A water source will be necessary for both the lagoon and the evaporation pan.

2. When constructing new lagoons, it may be more practical to install a permanent stilling well before filling the lagoon, rather than to use a temporary set-up.

3. A construction level will help in setting up the equipment properly.

4. On cloudy days, a flashlight may be helpful in seeing the hook gauge inside the stilling well.

5. Mean air temperature may be recorded using a HOBO temperature data logger.

6.3.3.7 DEFINITIONS

S_{r1} is the seepage rate in inches per day.

S_{r2} is the seepage rate in gallons per acre per day.

E_{s0} is the lagoon surface elevation, day 0 inches.

E_{sn} is the lagoon surface elevation, day n in inches.
ES is the lagoon surface elevation change in inches ($E_{s0} - E_{sn}$). Positive if the n day surface is lower than day 0; negative if the n day surface is higher than day 0.

I_L is the net lagoon evaporation which is calculated from the net corrected pan evaporation in inches (may be a positive or negative number).

Q is the net effluent flow in inches. May be positive (effluent > the influent flow) or negative (effluent < than influent flow). Value is zero if influent and effluent flows are blocked. (See equation on the next page).

n is time in days.
P is pan coefficient from Table 5.

E_{pan0} is the evaporation pan surface elevation, day 0 in inches.

$E_{pan\ n}$ is the evaporation pan surface elevation, day n in inches.

NOTE: All hook gauge readings must be subtracted from a datum elevation and multiplied by 12 to give water surface elevations in inches. The datum elevation may be assumed.

At a minimum, the following information should be recorded each time measurements are taken: date, time, air temperature, lagoon surface elevation (E_s), pan surface elevation (E_{pan}), precipitation, influent flow, and effluent flow. Then, the overall seepage rate for the testing period can be calculated using the following equations:

6.3.3.8 SEEPAGE RATE CALCULATIONS

Seepage Equation 1: $S_{r1} = \frac{ES - I_L - Q}{n} = \frac{\text{inches}}{\text{day}}$

Seepage Equation 2:

$$S_{r2} = S_{r1}\ \frac{[\text{in}]\ [1\ \text{ft.}]\ [43{,}560\ \text{ft.}^2]\ [7.48\ \text{gal.}]}{[\text{day}]\ [12\ \text{in}]\ [1\ \text{acre}]\ [\text{ft.}^3]} = \frac{\text{gallons}}{\text{acre/day}}$$

Where: $ES = E_{s0} - E_{sn} = \text{inches}$

$I_L = P[\text{precipitation} + E_{pan0} - E_{pan\ n}] - \text{precipitation}$

$Q = \frac{(\text{effluent flow - influent flow in gallons})\ (\text{ft.}^3)\ (12\ \text{in})}{} = \text{inches}$

(lagoon surface area ft.^{2}) (7.48 gals.) (ft.)

6.3.3.9 PAN EVAPORATION (I_P)

$I_p = P[\text{precipitation} + E_{pan0} - E_{pan\ n}] - \text{precipitation}$

NOTE: Solving for I_p in the above equation assumes that the precipitation event was short duration. If a precipitation event during a seepage test is of extended duration, P should be multiplied by the factor:

$$\frac{\text{n hours - precipitation hours}}{\text{n hours}}$$

Definitions:

I_p = Net pan evaporation
P = pan coefficient from Table 5
n = time of seepage test

Table 1. Evaporation Pan Coefficient, P

Mean Air Temp F	Pan Coeff P
30	1.0000
31	0.9906
32	0.9812
33	0.9718
34	0.9624
35	0.9530
36	0.9438
37	0.9346
38	0.9254
39	0.9162
40	0.9070
41	0.8976
42	0.8882
43	0.8788
44	0.8694
45	0.8600
46	0.8508
47	0.8416
48	0.8324
49	0.8232
50	0.8140
51	0.8046
52	0.7952
53	0.7858
54	0.7764
55	0.7670
56	0.7578
57	0.7486
58	0.7394
59	0.7302

Mean Air Temp F	Pan Coeff P
60	0.7210
61	0.7116
62	0.7022
63	0.6928
64	0.6834
65	0.6740
66	0.6648
67	0.6556
68	0.6464
69	0.6372
70	0.6280
71	0.6186
72	0.6092
73	0.5998
74	0.5904
75	0.5810
76	0.5720
77	0.5630
78	0.5540
79	0.5450
80	0.5360
81	0.5264
82	0.5168
83	0.5072
84	0.4976
85	0.4880

6.3.4 SUGGESTED LAGOON SEEPAGE TESTING SPECIFICATION INSERT

Lagoon Liner - Liner integrity of each individual cell shall be evaluated in the following manner:

a. Evaporation - Shall be measured utilizing a Class A evaporation pan and pan stilling well arrangement. Pan measurements accurate to 0.012 inch (0.001 foot) shall be taken six (6) times over a period of fifteen (15) days (day 0, 3, 6, 9, 12, 15,). The pan coefficient for comparison is dependent on the mean air temperature (F^o) over the test period and shall be taken from Table 5.

b. Precipitation/Air Temperature - Precipitation shall be measured using a standard precipitation gauge accurate to the nearest 0.01 inch. Measurements shall be recorded following each precipitation event. Air temperature (F^o) shall be monitored and recorded, using a recording data logger such as a HOBO.

c. Lagoon - New or Existing Cells - Shall be filled and maintained at design operating level for at least two weeks prior to testing (not required for synthetic liners). During the test period, influent/effluent flows shall be blocked. A level, fixed stilling well located as near to the center of the lagoon as possible shall be used at the point for measurement. Measurements accurate to 0.012 inch (0.001 foot) shall be taken six (6) times over a period of fifteen (15) days (day 0, 3, 6, 9, 12, 15).